4.3 Hazard Area 3 - Bethel Valley

The Bethel Valley watershed encompasses approximately 1700 acres, including the main industrial complex of Oak Ridge National Laboratory. Bethel Valley is defined by the upper drainage area of White Oak Creek and its tributaries and extends from the Clinch River at its west end to the easternmost boundary of ORNL. The northern boundary lies somewhat north of Bethel Valley Road; the southern boundary is the crest of Haw Ridge, which is the hydrologic divide between Bethel Valley and Melton Valley. Bethel Valley includes the main administrative offices and research facilities of ORNL. Bethel Valley is subdivided into four regions with varied land use and level of contamination: Raccoon Creek, West Bethel Valley, Central Bethel Valley, and East Bethel Valley. Raccoon Valley is located west of Highway 95 and is wooded land that contains no known contamination source areas but slightly contaminated media due to the migration of contaminants from West Bethel Valley. East Bethel Valley includes the ORNL plant maintenance area, Central Bethel Valley includes the main ORNL plant area, and West Bethel Valley contains a burial ground and a small portion of the plant area.

Deleted: that have migrated

ORNL was originally constructed in 1943 to produce the first gram quantities of plutonium for use in the atomic bomb for the Manhattan Project during World War II. After the war, it was established as a national laboratory and it continues to conduct applied research and engineering development in support of DOE programs in nuclear energy, fusion, energy conservation, fossil fuels, and other energy technologies, and to perform basic and applied scientific research and development in physical, chemical, materials, biological, environmental, social and computational sciences. ORNL's operations during the past 60 years have resulted in a legacy of sites and facilities contaminated with a wide variety of hazardous and radioactive materials. Contaminated sites include numerous tanks, four surface impoundments, reactors and associated buildings, buried waste transfer pipelines, and burial grounds and landfills. Interim actions have been conducted under CERCLA for several Bethel Valley facilities, notably including the Surface Impoundment Operable Unit (SIOU), the Gunite and Associated Tanks, and the Corehole 8 Plume.

The *Record of Decision for Interim Actions Bethel Valley* (DOE 2002b) was approved on May 2, 2002. Remedial actions selected under the ROD include a combination of containment, stabilization, removal, treatment, monitoring, and land use controls. The selected remedial actions are designed to significantly reduce the release of contaminants from Bethel Valley sources into White Oak Creek and subsequently the Clinch River. White Oak Creek is the primary exit pathway for mobile contaminants in Bethel Valley. The point of integration for contaminants in Bethel Valley is where White Oak Creek exits the watershed at 7500 Bridge. Monitoring at this location provides a watershed-scale measure for remedial action effectiveness. The Bethel Valley watershed currently discharges to the Melton Valley watershed, where additional contaminants enter White Oak Creek before being discharged over White Oak Dam to the Clinch River.

Remediation criteria are specified in the Bethel Valley ROD for soils, floodplain sediments, and surface water. Remediation goals for surface water are to achieve Ambient Water Quality

Criteria (AWQC) in waters of the State of Tennessee, protect an off-site resident user of surface water, and protect the Clinch River to meet its stream use classification. Remediation of surface water sediment was deferred to a future decision. Remediation criteria for soils were derived to limit potential risk to a hypothetical future worker not to exceed 1 x 10^{-4} ELCR and HI≤3. In addition, remediation criteria are specified for unrestricted land use in the relatively undeveloped and non-impacted areas of Bethel Valley. These values are summarized in Table 4-3.

Table 4-3. Soil Remediation Criteria from the Bethel Valley ROD

Principal COC in Soil	Selected Remediation Concentration for Industrial Worker	Selected Remediation Concentration for Unrestricted Areas
Carcinogens		
Benz(a)anthracene	260 mg/kg	86 mg/kg
Benzo(a)pyrene	26 mg/kg	8.6 mg/kg
Benzo(b)fluoranthene	250 mg/kg	86 mg/kg
Dibenz(a,h)anthracene	26 mg/kg	8.6 mg/kg
N-nitroso-di-n-propylamine	-	7.8 mg/kg
Cobalt-60	7.4 pCi/g	4 pCi/g
Iodine-129	1400 pCi/g	-
Cesium-137+D	14 pCi/g	7 pCi/g
Europium-152	9.5 pCi/g	5 pCi/g
Europium-154	11 pCi/g	6 pCi/g
Europium-155	710 pCi/g	-
Lead-210+D	270 pCi/g	-
Radium-226+D*	3 pCi/g	3 pCi/g
Radium-228+D*	3 pCi/g	-
Thorium-228+D*	3 pCi/g	-
Thorium-232+D*	3 pCi/g	3 pCi/g
Uranium-235+D	-	37 pCi/g
Uranium-238+D	310 pCi/g	91 pCi/g
Plutonium-240	540 pCi/g	-
Americium-241	450 pCi/g	-
Noncarcinogens		
Arsenic	330 mg/kg	-

*Criteria for the Radium-226 and Thorium-232 decay series are non-risk-based values, set at 3 pCi/g above site-specific background concentrations. All other criteria are risk-based concentrations for the protection of a hypothetical future worker, and include any contributions from background.

An exposure unit approach like that described previously for Melton Valley is used, where both an average remediation level (averaged across the exposure unit) and a maximum remediation level (not to be exceeded at any location) are specified for each contaminant of concern. Where multiple COCs are present within an exposure unit, a sum-of-the-ratios approach must be used to ensure that the cumulative risk to the future worker from all contaminants does not exceed 1 x 10^{-4} ELCR (excluding the radium and thorium decay series) and HI≤3.

Deleted: may

The selected remedy provides overall protection of reach-level populations of aquatic species, valley-wide populations of wide-ranging ecological species, and area-wide populations of terrestrial species in West Bethel Valley, the only area with sufficient habitat. Groundwater treatment actions for mercury and removal of contaminated sediments in the streams will allow AWQC to be met and will protect the aquatic species in those streams. Soil removal actions in West Bethel Valley will remove a threat to individuals of terrestrial species (populations are already protected). These actions, especially the sediment removal actions, will have some short-term effects on ecological populations, but it is planned to restore those habitats quickly.

Bethel Valley Current State:

Wastes in Bethel Valley resulted from nuclear reactors, radioisotope operations, particle accelerators, hot cell operations, physical, chemical and biological research, fuel chemical reprocessing research, analytical laboratories, and other research and development operations and support facilities. The major areas of contamination in Bethel Valley include:

- The ORNL Main Plant Area includes active and inactive facilities, four inactive research reactors, numerous underground waste tanks, miles of associated pipeline, surface impoundments and contaminated soils. Strontium-90 is a major contaminant associated with releases from surface impoundments. Contaminated soils have resulted from liquid waste transfer pipeline leaks and spills. Pipeline and tank leaks also have contributed to groundwater contamination. The Corehole 8 groundwater plume is contaminated with strontium-90 and uranium, which resulted from a broken pipe in the North Tank Farm. A major challenge for remediation of the Main Plant Area is the extensive underground network of tanks and pipelines used for radionuclide processing and waste treatment.
- Solid Waste Storage Area 3 (SWSA 3) was used for disposal of low-level and transuranic wastes. Seepage from this area flows into shallow groundwater and then to nearby surface water. Contaminants of concern for SWSA 3 include cesium-137 and strontium-90.
- Radiologically contaminated surface soil poses a risk to workers. Some subsurface contaminated soil resulting from liquid low-level waste pipeline leaks and other sources may contribute to groundwater contamination. The sediment and floodplain soil associated with on-site creeks is contaminated with radionuclides and mercury.
- Groundwater contaminated with strontium-90 and mercury currently discharges to surface water.

Deleted: Waste Area Grouping

The Baseline Risk Assessment (DOE 1999a) identified the following potentially unacceptable risks for the Bethel Valley watershed:

- Soil and Sediment Contamination – Concentrations of radionuclides in soils and sediments present unacceptable risk (>1 x 10^{-4} ELCR) to future workers, primarily via the direct external pathway. Cesium-137 is the predominant contaminant of concern, and other contributors include cobalt-60 and the thorium-232 decay series.
- Burial Ground Contamination – SWSA 3 and associated soils present unacceptable risk (>1 x 10^{-4} ELCR) to future industrial workers.

- Building and Facility Contamination – Contaminated buildings, tanks, pipelines, and other facilities, particularly in Central Bethel Valley, present an unacceptable risk (>1 x 10^{-4} ELCR) to future industrial workers.
- Surface Water Contamination – Contamination from Bethel Valley contributes to unacceptable levels of strontium-90 at White Oak Dam in Melton Valley. Surface water in First Creek exceeds 1 x 10^{-4} ELCR to future workers.
- Groundwater Contamination – Groundwater has been significantly impacted by past operations. Numerous contaminants (e.g., strontium-90, tritium, VOCs) exceed MCLs, although groundwater is not currently used for industrial or other purposes at Bethel Valley.
- Ecological Risks – Potentially unacceptable risks to aquatic and terrestrial biota also were identified. COCs include metals (primarily mercury) in surface water; metals, PCBs and PAHs in sediment; and radionuclides (primarily cesium-137) in soil.

Life-Cycle Baseline Plan for Bethel Valley:

Under the current baseline, certain actions with opportunities for high risk reduction in Bethel Valley would be completed by 2008:

- The Bethel Valley Groundwater Engineering Study will be conducted to identify sources of groundwater contamination.
- The Corehole 8 removal action will be completed, including removal of tank W-1A and surrounding contaminated soils for off-site disposal.
- Completion of the Corehole 8 Plume groundwater extraction will be implemented to minimize further impacts to groundwater and to protect surface water bodies from contaminated discharges. Four deep extraction wells will be installed to collect water from bedrock, and sumps will be installed near storm drain junction boxes to collect and treat contaminated shallow groundwater. Enhanced biodegradation will be implemented in East Bethel Valley to address a volatile organic compound plume.
- The removal and off-site disposal of contaminated sediments from the Surface Impoundments Operable Unit was completed in 2003. Radiologically contaminated sediments were removed from these four former surface impoundments under an interim ROD issued in 1997. Most of this waste was successfully disposed at the EMWMF resulting in a significant cost savings relative to the off-site disposal alternative previously planned.

The remainder of remedial actions in the Bethel Valley watershed would be completed by 2015, including the following:

- Inactive buildings/facilities will be demolished and the Graphite Reactor core will be stabilized.
- Soil will be removed above remediation levels established for worker protection to a maximum depth of 2 feet in the controlled industrial area, and soil will be removed above remediation levels established for worker protection to a maximum depth of 10 feet in the unrestricted industrial area.
- Solid Waste Storage Area 3 will be hydraulically isolated through capping.

Deleted: <#>Fuel salts from the Molten Salt Reactor Experiment (MSRE) will be removed for off-site disposal.¶
<#>Resin beads will be removed from the T1, T2, and High Flux Isotope Reactor (HFIR) tanks and the tanks grouted in place.¶

- Institutional controls will be maintained in perpetuity to control future land use, to restrict access to capped waste disposal areas, and to prohibit onsite use of groundwater.

Risk-Based End State Vision for Bethel Valley:

Current baseline plans for Bethel Valley are designed to support the planned industrial end use of the ORNL site, and remediation criteria were derived to achieve an acceptably low level of risk to the future workers. The actions planned under the current baseline are considered to be generally consistent with remedial actions designed solely on the basis of the risk-based end state. No specific variances have been identified to date for Bethel Valley.

The remedy contained in the existing ROD for Bethel Valley is based on future use of portions of the site for DOE-controlled industrial use, other portions for uncontrolled industrial use, and still other portions for unrestricted use. Remediation criteria for each of these subareas are derived to limit the potential risk to a future industrial worker not to exceed 1×10^{-4} ELCR and HI≤3, and thus the remedy is considered RBES. However, since DOE plans to maintain ownership and control over the entire Bethel Valley watershed for the foreseeable future in support of the ongoing ORNL mission, the division of the site into these different land use categories may be unnecessary. If the end-use designation is changed in the future, the selected remedy should be reevaluated with respect to the RBES.

Maps of the Bethel Valley watershed under current and RBES conditions are provided in Figures 4.3a1 and 4.3b1. Conceptual site models under current state and RBES conditions are illustrated in Figures 4.3a2 and 4.3b2, respectively.

The RBES scenario for Bethel Valley is considered to be identical to the current baseline. Contaminants in buildings, soil, and other materials above risk-based criteria for industrial use will be removed for off-site disposal. A long-term stewardship program will ensure the continuing protectiveness of the remedy, including continuing surveillance and maintenance. The containment system for the capped area at SWSA 3 will require periodic maintenance and repair to minimize the potential for failure. Groundwater monitoring wells will require periodic maintenance and replacement at longer intervals (assumed 30 years). Since contaminants will remain on site above levels suitable for unlimited use and unrestricted exposure, a statutory review will be conducted at least every five years to ensure that the remedy continues to be protective of human health and the environment. The DOE Office of Science will retain ownership of the Bethel Valley watershed and the remainder of ORNL for the foreseeable future.

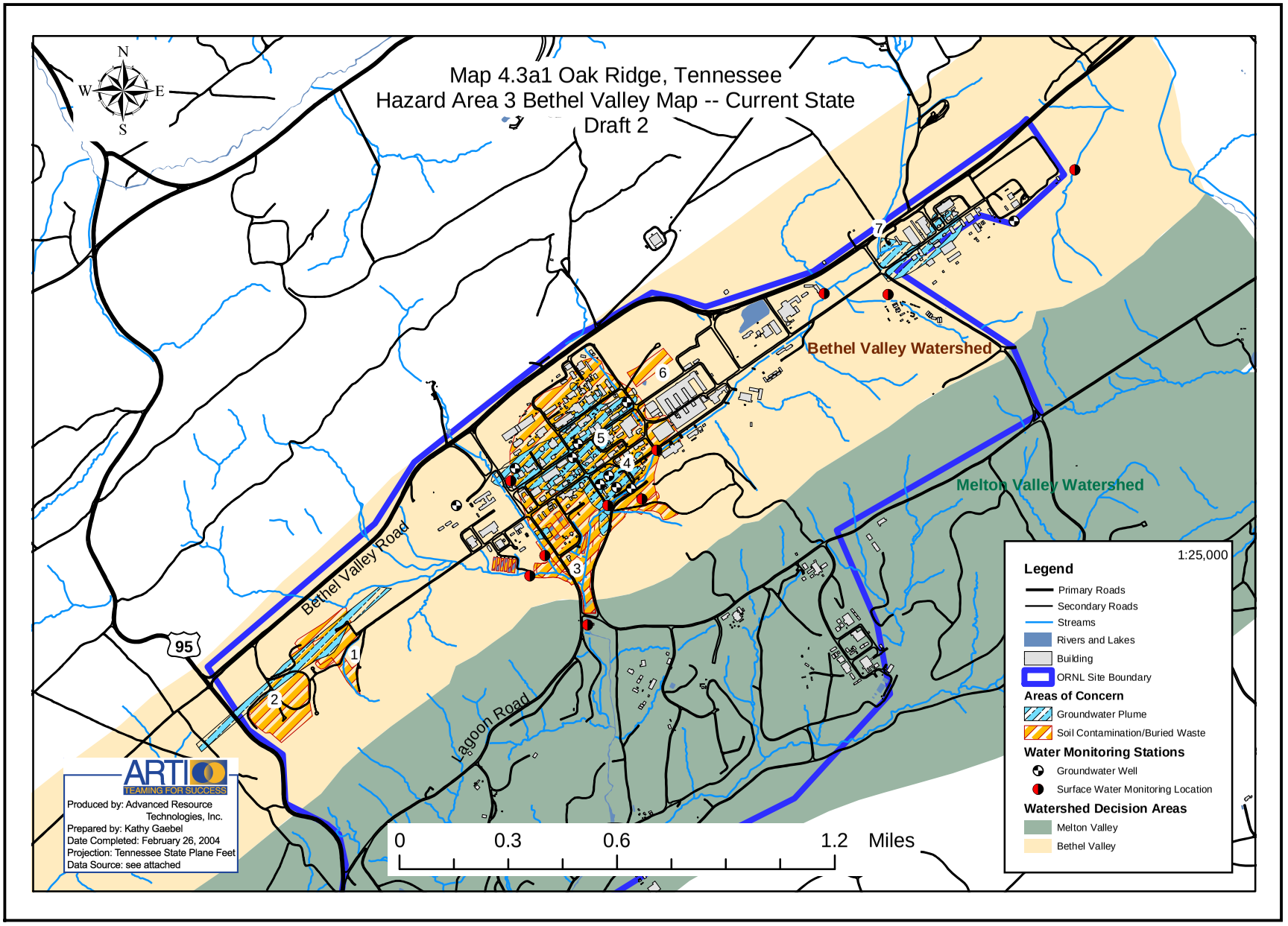

Map 4.3a1 Oak Ridge, Tennessee
Hazard Area 3 Bethel Valley Map -- Current State
Draft 2
N
W
E
S
Bethel Valley Watershed
Melton Valley Watershed
Bethel Valley Road
Lagoon Road
95
1
2
3
4
5
6
7
1:25,000
Legend
Primary Roads
Secondary Roads
Streams
Rivers and Lakes
Building
ORNL Site Boundary
Areas of Concern
Groundwater Plume
Soil Contamination/Buried Waste
Water Monitoring Stations
Groundwater Well
Surface Water Monitoring Location
Watershed Decision Areas
Melton Valley
Bethel Valley
0
0.3
0.6
1.2 Miles
ARTI
TEAMING FOR SUCCESS
Produced by: Advanced Resource Technologies, Inc.
Prepared by: Kathy Gaebel
Date Completed: February 26, 2004
Projection: Tennessee State Plane Feet
Data Source: see attached

Figure 4.3a1 Continued

Notes for Bethel Valley current state map:

1. Solid Waste Storage Area 3 (SWSA 3) – 7-acre burial ground used for disposal of radioactive waste from 1946 to 1951; disposal practices used unlined trenches backfilled with soil. Groundwater contamination consists primarily of strontium-90.

2. Contractor's Landfill – disposal site for construction debris and demolition materials; some materials may be lightly contaminated.

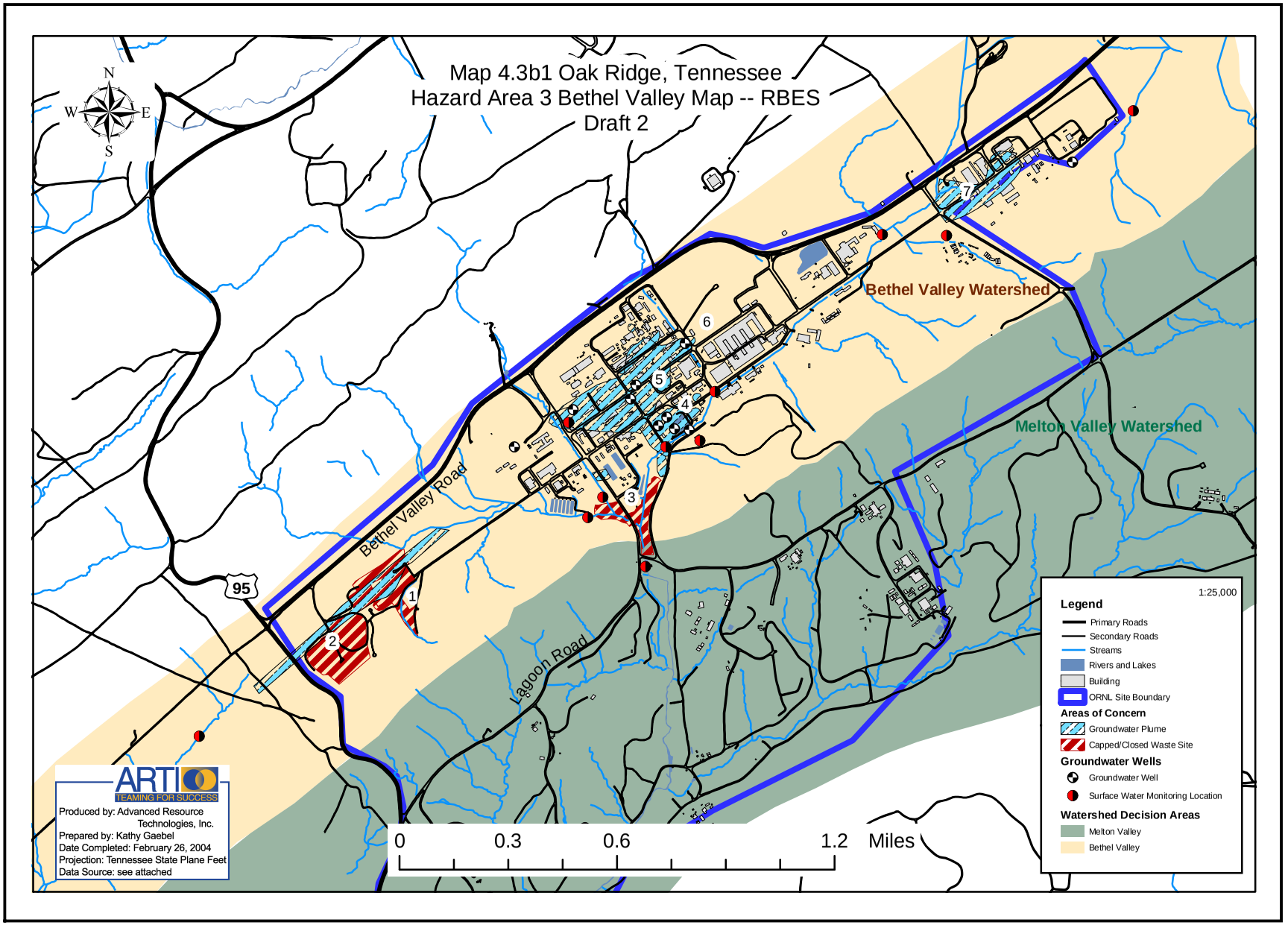
3. Solid Waste Storage Area 1 (SWSA 1) area – includes SWSA 1, a 1-acre burial ground used from 1943-1944, the former waste pile area (FWPA), and the nonradiological wastewater treatment plant (NRWTP) debris pile.

4. Surface Impoundments – remediation completed in FY 2003, including removal and off-site disposal of contaminated sediments.

5. North Tank Farm and South Tank Farm area – numerous underground storage tanks previously used for storage of radioactive and hazardous chemical wastes; most tanks have been removed or remediated in place; soil contamination and groundwater contamination (primarily strontium-90 and tritium) remains, as well as localized source areas (e.g., Tank W-1A soils for Core Hole 8 plume). Since 1994, DOE has been conducting a series of early actions to minimize the release of contaminated groundwater from the Core Hole 8 plume to surface water, including collection and treatment of contaminated groundwater and removal of a portion of the source.

6. Solid Waste Storage Area 2 (SWSA 2) – 3.6-acre burial ground in Central Bethel Valley used for disposal of radioactive wastes from 1944 to 1946; SWSA 2 wastes exhumed and relocated to SWSA 3 in 1946; residual soil contamination remains.

7. 7000 Area – VOC contamination in groundwater is the only identified VOC plume in Bethel Valley (groundwater contamination in other areas of Bethel Valley consists primarily of radionuclides, particularly Sr-90 and H-3).


Map 4.3b1 Oak Ridge, Tennessee
Hazard Area 3 Bethel Valley Map -- RBES
Draft 2
N
W
E
S
Bethel Valley Watershed
Melton Valley Watershed
Bethel Valley Road
Lagoon Road
95
1
2
3
4
5
6
7
0
0.3
0.6
1.2
Miles
1:25,000
Legend
Primary Roads
Secondary Roads
Streams
Rivers and Lakes
Building
ORNL Site Boundary
Areas of Concern
Groundwater Plume
Capped/Closed Waste Site
Groundwater Wells
Groundwater Well
Surface Water Monitoring Location
Watershed Decision Areas
Melton Valley
Bethel Valley
ARTI
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Produced by: Advanced Resource Technologies, Inc.
Prepared by: Kathy Gaebel
Date Completed: February 26, 2004
Projection: Tennessee State Plane Feet
Data Source: see attached

Figure 4.3b1 Continued

Notes for Bethel Valley RBES map:

1. Solid Waste Storage Area 3 (SWSA 3) – multi-layer cap installed over waste disposal area; groundwater contamination requires continued institutional controls.

2. Contractor's Landfill – multi-layer cap installed over waste disposal area.

3. Solid Waste Storage Area 1 (SWSA 1) area – multi-layer caps will in installed at SWSA 1, a 1-acre burial ground used from 1943-1944, the former waste pile area (FWPA), and the nonradiological wastewater treatment plant (NRWTP) debris pile.

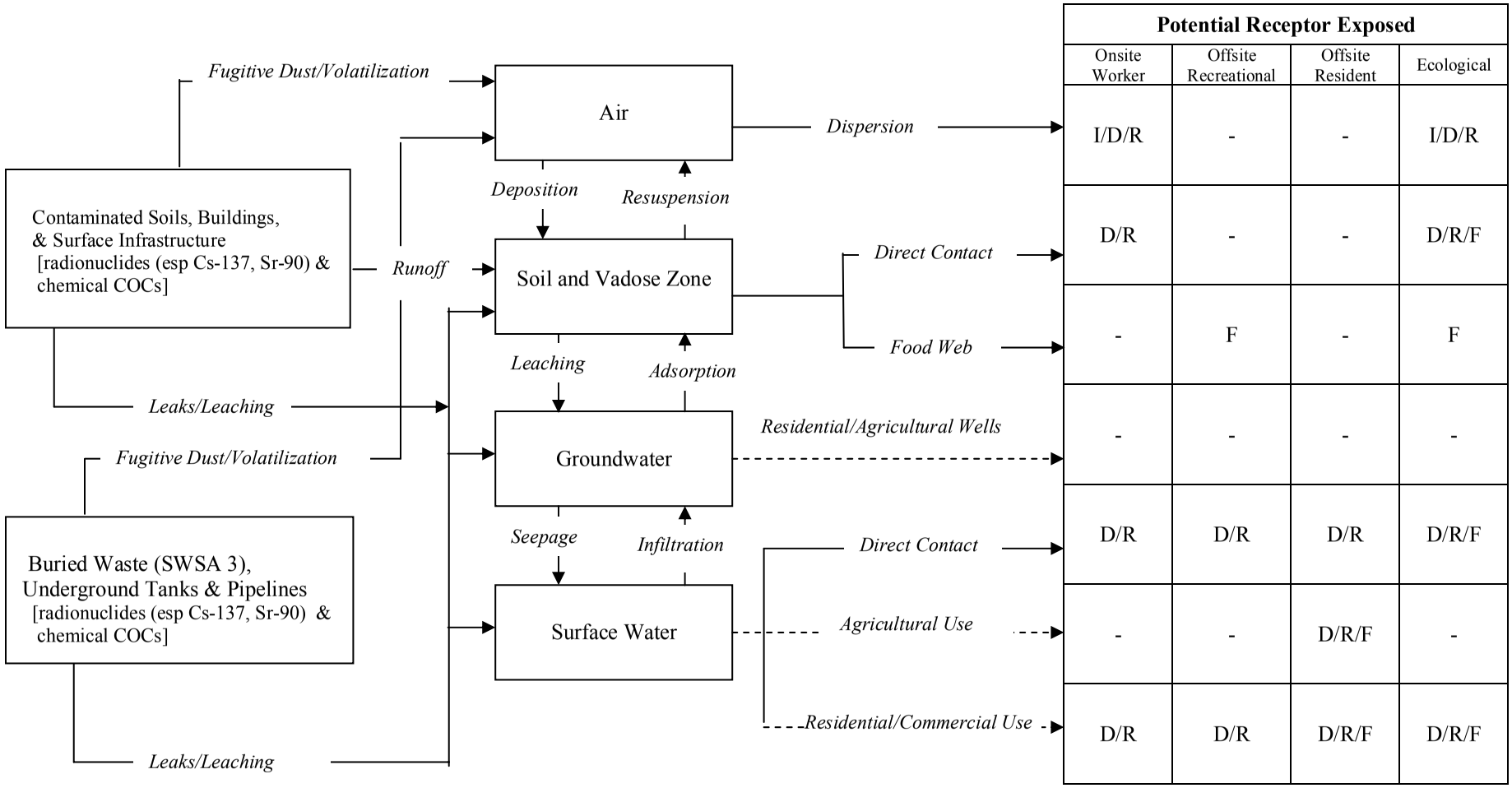
4. Surface Impoundments – remediation completed in FY 2003. All sediment has been removed from the four impoundments and treated; the resulting 981 solidified concrete waste forms have been disposed of either at EMWMF or off-site disposal facilities.

5. North Tank Farm and South Tank Farm area – tanks and contaminated soils remediated to risk-based criteria for industrial use; source removal actions for the Core Hole 8 Plume will be completed and actions to minimize the release of groundwater contamination to surface water and to minimize further spread of the groundwater plume will continue; groundwater contamination requires continued institutional controls.

6. SWSA 2 – residual soil contamination remediated to risk-based criteria for industrial use.

7. 7000 Area – VOC groundwater plume will undergo monitored natural attenuation and require continued institutional controls.

Figure 4.3a2, Conceptual Site Model - Hazard Area 3, Bethel Valley – Current State



Potential Receptor Exposed			
Onsite Worker	Offsite Recreational	Offsite Resident	Ecological
I/D/R	-	-	I/D/R
D/R	-	-	D/R/F
-	F	-	F
-	-	-	-
D/R	D/R	D/R	D/R/F
-	-	D/R/F	-
D/R	D/R	D/R/F	D/R/F

KEY

Active transport, uptake, or exposure pathway

Blocked or mitigated transport, uptake, or exposure pathway

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

Figure 4.3a2, Conceptual Site Model - Hazard Area 3, Bethel Valley – Current State

Narrative:

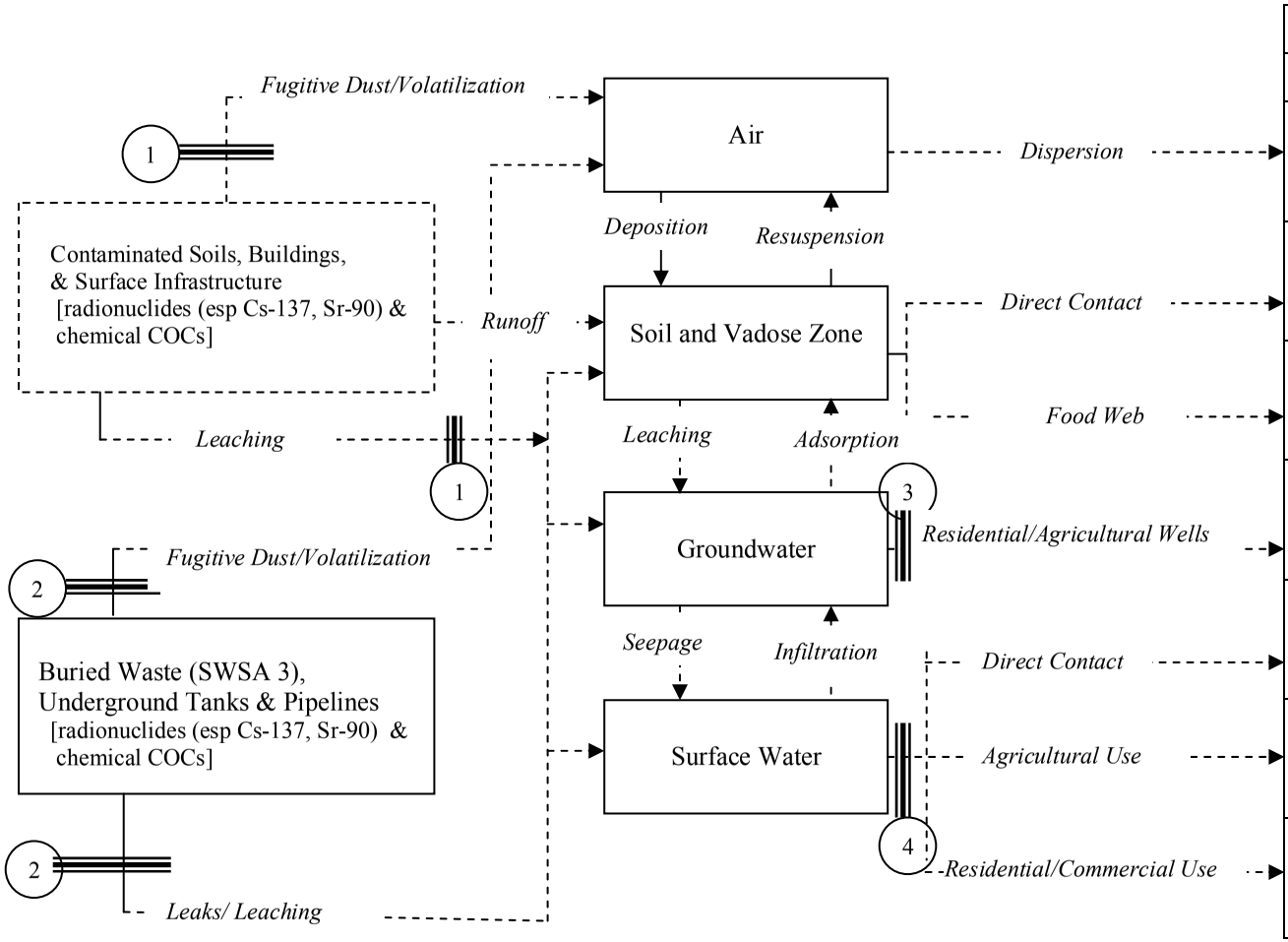
Contaminant Sources:

Bethel Valley includes the main industrial complex of Oak Ridge National Laboratory. Facility operations during the past 60 years have resulted in a large number of sites and facilities contaminated with a variety of radioactive and hazardous contaminants; contaminated sites include numerous buildings, tanks, surface impoundments, reactors, above- and below-ground pipelines and utilities, and buried waste sites. Contaminants of concern include numerous radionuclides and chemicals, particularly Cs-137 and Co-60 in soil and sediments, and Sr-90 in surface water. Under the existing CERCLA ROD approved in 2002, remediation criteria are specified for soils, floodplain sediment, and surface water, based on future industrial use of the site. Remediation criteria for contaminants of concern in soil were derived to limit risks to future industrial workers not to exceed 1×10^{-4} ELCR and HI<3. Remediation goals for surface water are to achieve AWQC, to proctect an off-site resident user of surface water, and to protect the Clinch River to meet its stream use classification. Numerous contaminants (Sr-90, H-3, VOCs) in groundwater exceed MCLs, although there is no current use of groundwater at Bethel Valley. Institutional controls include restrictions on future groundwater and surface water use in Bethel Valley.

Current State Exposure Pathways and Receptors:

Under current conditions, potentially complete exposure pathways for onsite workers include: inhalation of resuspended particulates or volatiles; and direct exposure to contaminants in soils, waste and surface water. While Bethel Valley is not normally accessible to recreational users, potentially complete exposure pathways to off-site recreationists include direct contact with surface water and ingestion of fish. Ecological receptors potentially may be exposed to contaminants in air, soil, surface water and the food chain. Surface water in Bethel Valley enters White Oak Creek and flows through Melton Valley to White Oak Lake, where it exits the ORR. Potentially complete exposure pathways to offsite residents include direct contact with surface water after exiting the ORR, fish ingestion, and use of surface water for irrigation of home gardens. There is no current use of groundwater or surface water in Bethel Valley for residential, commercial, or agricultural purposes.

Figure 4.3b2, Conceptual Site Model – Hazard Area 3, Bethel Valley – RBES



Potential Receptor Exposed			
Onsite Worker	Offsite Recreational	Offsite Resident	Ecological
I/D/R	-	-	I/D/R
D/R	-	-	D/R/F
-	F	-	F
-	-	-	-
D/R	D/R	D/R	D/R/F
-	-	D/R/F	D/R/F
D/R	D/R	D/R/F	D/R/F

KEY

Active transport, uptake, or exposure pathway

Blocked or mitigated transport, uptake, or exposure pathway

Engineered barrier or administrative control – sequentially numbered

I – Inhalation
D – Dermal contact R – Direct Radiation Exposure
F – Ingestion

Figure 4.3b2, Conceptual Site Model – Hazard Area 3, Bethel Valley – RBES

Narrative:

Contaminant Sources:

Under both current life-cycle baseline and Risk-Based End State conditions, the Bethel Valley watershed will continue to be used for the operation of Oak Ridge National Laboratory, i.e. DOE-controlled industrial use. Contaminants of concern include Cs-137 and Co-60 in soil and sediments, and Sr-90 in surface water. Remediation criteria for contaminants of concern in soil and other media were derived to limit risks to the future industrial workers not to exceed 1×10^{-4} ELCR and HI<3. Institutional controls include restrictions on access to the waste management areas and restrictions on future groundwater and surface water use throughout Bethel Valley.

Risk-Based End State Barriers/Interventions:

The steps taken to mitigate or remove these hazards are as follows:

1. Contaminated buildings and soils within Bethel Valley will be remediated such that contaminants of concern do not exceed risk-based remediation criteria for industrial use. Contaminated media above remediation criteria generally will be removed for disposal at the EMWMF disposal facility. Inactive buildings and facilities will be demolished and removed. Residual contaminant levels will be below levels of concern for fugitive dust emissions/volatilization or direct radiation exposure. While the ROD specifies that soil will be remediated to a depth of 2 ft in some areas and 10 ft in others, under the RBES conditions, the depth of soil remediation is taken to be 2 ft throughout Bethel Valley.

2. Most underground tanks and pipelines will be contained in place via grouting , use of cover systems and other hydraulic controls. The SWSA 3 burial ground will be hydraulically isolated via installation of a multi-layer engineered cover system. The engineered containment systems will preclude unacceptable exposures to workers or releases of contaminants to the environment above levels of concern. Institutional controls will be maintained in perpetuity to restrict access to the grouted or capped sites.

3. Future land use within Bethel Valley will be restricted to industrial use, and institutional controls will prohibit groundwater use. The ongoing groundwater extraction project for the Corehole 8 Plume will be completed to minimize further impacts to groundwater and to protect surface water from contaminated discharges. Long-term stewardship and institutional controls will ensure continuing protectiveness of the remedy. Surveillance and maintenance will include monitoring of surface water and groundwater, with periodic maintenance and replacement of groundwater wells and ongoing maintenance of capped areas as required.

4. As noted in the discussion for Melton Valley, remediation of surface water and sediment in White Oak Creek has been generally deferred to a future CERCLA decision. It is anticipated that the actions described in items 1 and 2 above, along with other remedial actions for Bethel Valley, will significantly reduce the flux of contaminants into surface water of White Oak Creek and White Oak Lake, which are ultimately discharged to the Clinch River upon exiting the ORR. Institutional controls include restrictions on current use of surface water within Bethel Valley.